Autonomous Take Off and Flight of a Tethered Glider for Airborne Wind Energy.

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**Objectives:**
I. Manual tethered take off and flight
II. Automatic flight
III. Automatic tethered flight
IV. Automatic tethered take off and flight

**Solutions and Results:**
- Development of a custom autopilot
- Hierarchical controller for automatic flight
- Assessment through flight simulations
- Accomplishment of objectives in flight tests

Airborne Wind Energy (AWE) is a new way to harvest wind power using soft kites or rigid wings, similar to gliders, flying cross wind and pulling on a tether. These platforms fly at high altitudes where winds are faster and more constant. Autonomous operation, including take off and landing, is required for the industrial deployment of such technology.

At ABB we developed a Ground Station (GS) able to autonomously Launch a tethered glider.

In a first part of the project, we built the GS and obtained manual tethered flights. The goal of the master project was to make it possible to autonomously take off from the GS and fly with the tether.

Manual tethered take off maneuvers were first obtained after Modification of the GS. In parallel, we developed our autopilot based on Arduino Mega and a professional navigation unit. We then used an approximated and decoupled model of the glider’s dynamics which we identified using flight data. We used this model to design State Feedback controllers that regulate Euler angles and rotation rates.

A High Level controller takes care of the altitude and heading control using target points and a Vector Field algorithm for landing.

We assessed the performance of this control scheme in simulations using a model developed during the first part of the project and then started the flight tests.

We quickly achieved autonomous tethered flight followed by autonomous tethered take off and flight.